

**UNIVERSITY OF ILLINOIS
AT URBANA-CHAMPAIGN**

Institute of Natural Resource Sustainability
 Illinois Natural History Survey
 1816 South Oak Street
 Champaign, IL 61820



MEMORANDUM

April 21, 2010

Re: Acute sulfate toxicity data

To: Charles Stephan, U.S. Environmental Protection Agency
 From: David J. Soucek, Illinois Natural History Survey (INHS)

This is intended to be a compilation of the results of all of the acute toxicity tests that were performed by INHS on sodium sulfate from 2004 to 2007. All tests were static. The dilution waters used in these tests were various reconstituted waters.

The acute value is stated in terms of mg sulfate/L and is based on measured concentrations of sulfate. The test material for all tests was reagent-grade (99%) sodium sulfate. The acute value is the 96-hr LC50 for *H. azteca* and *S. simile* and is the 48-hr EC50 for *C. dubia* and *C. tentans*.

All acute values were calculated using the trimmed Spearman-Karber method.

Test organisms were not fed during any of the tests. In most of the tests test organisms were not acclimated to the dilution water before the beginning of the test.

Most of these tests were reported in the following publications:

- a. Soucek, D.J., and A.J. Kennedy. 2005. Effects of Hardness, Chloride, and Acclimation on the Acute Toxicity of Sulfate to Freshwater Invertebrates. Environ. Toxicol. Chem. 24(5):1204-1210.
- b. Soucek, D.J. 2007. Comparison of Hardness- and Chloride-Regulated Acute Effects of Sodium Sulfate on Two Freshwater Crustaceans. Environ. Toxicol. Chem. 26(4):773-779.

Species	Acute Value	Chloride (mg/L) ^a	Hardness (mg/L) ^b	Ca-Mg Ratio ^c	Calcium (mg/L)
<i>H. azteca</i> @	431	5	89	1.46	17.6
<i>H. azteca</i> @	524	5	89	1.46	17.6
<i>H. azteca</i> @	607	5	89	1.46	17.6
<i>H. azteca</i> @	1558	12.08333	95 (94)	2.33	23.5
<i>H. azteca</i> @	1359	11.5000	98 (96)	2.33	23.5
<i>H. azteca</i> @	1210	11.43333	97 (94)	2.33	23.5
<i>H. azteca</i> @	1485	16.750	99 (98)	2.33	23.5
<i>H. azteca</i> @	1699	17.00	100	2.33	23.5
<i>H. azteca</i> @	1460	15.560	102 (100)	2.33	23.5
<i>H. azteca</i> @	1810	20.65	110 (108)	2.33	23.5
<i>H. azteca</i> @	1505	21.81667	99 (102)	2.33	23.5
<i>H. azteca</i> @	1348	22.38333	102 (100)	2.33	23.5
<i>H. azteca</i> †@	2000	25.45	107 (106)	2.33	23.5
<i>H. azteca</i> †@	1901	25.63333	102 (100)	2.33	23.5
<i>H. azteca</i> †@	1621	25.86667	99 (98)	2.33	23.5

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H. azteca ^{†@}	2002	26.11667	102	2.33	23.5
H. azteca [†]	1767	33.63333	100 (96)	2.33	23.5
H. azteca [†]	1820	33.71667	100	2.33	23.5
H. azteca [†]	1779	33.9	100 (96)	2.33	23.5
H. azteca [†]	1879	108	103 (98)	2.33	23.5
H. azteca [†]	1830	105.5	100	2.33	23.5
H. azteca [†]	2002	105.6667	104 (100)	2.33	23.5
H. azteca [†]	1679	308	100 (98)	2.33	23.5
H. azteca [†]	1616	310.1667	100 (96)	2.33	23.5
H. azteca [†]	1684	303.6667	104 (100)	2.33	23.5
H. azteca [†]	1433	485	99 (98)	2.33	23.5
H. azteca [†]	1480	525.5	102 (100)	2.33	23.5
H. azteca [†]	1438	445	104 (100)	2.33	23.5
H. azteca ^{†@}	2740	25.1	192 (194)	2.33	47.1
H. azteca ^{†@}	2203	26.28333	200 (192)	2.33	47.1
H. azteca ^{†@}	2955	25.63333	199 (196)	2.33	47.1
H. azteca ^{†@}	2121	24.91667	294 (296)	2.33	70.6
H. azteca ^{†@}	3462	25.26833	293 (292)	2.33	70.6
H. azteca ^{†@}	2840	26.59	293 (292)	2.33	70.6
H. azteca ^{†@}	2724	25.4	398 (392)	2.33	94.1
H. azteca ^{†@}	4046	25.54	398 (396)	2.33	94.1
H. azteca ^{†@}	4336	25.54	398 (396)	2.33	94.1
H. azteca ^{†@}	4145	24.88	487 (486)	2.33	117.7
H. azteca ^{†@}	4345	24.96	485 (482)	2.33	117.7
H. azteca ^{†@}	3796	25.31	485 (482)	2.33	117.7
H. azteca	3400	25.0	585	2.33	141.2
H. azteca	3785	25.2	608	2.33	141.2
H. azteca	2986	25.9	608	2.33	141.2
C. dubia	2030	5	89	1.46	17.6
C. dubia	1869	5	89	1.46	17.6
C. dubia	2270	5	89	1.46	17.6
C. dubia	2446	12.2	100	2.33	23.5
C. dubia	2297	12.2	100	2.33	23.5
C. dubia	2542	12.5	103	2.33	23.5
C. dubia	2188	15.4	96	2.33	23.5
C. dubia	2269	15.4	94	2.33	23.5
C. dubia	2333	15.7	99	2.33	23.5
C. dubia	2433	20.8	97	2.33	23.5
C. dubia	2263	20.4	96	2.33	23.5
C. dubia	2516	20.2	96	2.33	23.5
C. dubia [†]	2198	25.26	100	2.33	23.5
C. dubia [†]	2724	25.32	96	2.33	23.5
C. dubia [†]	1925	25.06	96	2.33	23.5
C. dubia [†]	2472	24.61	100 (96)	2.33	23.5
C. dubia [†]	2481	24.85	100 (96)	2.33	23.5
C. dubia [†]	2404	100.3667	96	2.33	23.5

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C. dubia [†]	2757	101.5	98 (96)	2.33	23.5
C. dubia [†]	2184	102.8333	103 (104)	2.33	23.5
C. dubia [†]	1830	273.6667	99 (98)	2.33	23.5
C. dubia [†]	1793	281.3333	103 (102)	2.33	23.5
C. dubia [†]	2095	288.3333	105 (102)	2.33	23.5
C. dubia [†]	1328	491	102 (96)	2.33	23.5
C. dubia [†]	1828	491.6667	101 (98)	2.33	23.5
C. dubia [†]	1116	497.6667	99 (94)	2.33	23.5
C. dubia	3059	1.9 *	194	1.46	39.1
C. dubia	2706	1.9 *	194	1.46	39.1
C. dubia	3265	1.9 *	194	1.46	39.1
C. dubia	2383	1.9 *	288	1.46	56.6
C. dubia	3361	1.9 *	288	1.46	56.6
C. dubia	2853	1.9 *	288	1.46	56.6
C. dubia	3297	1.9 *	288	1.46	56.6
C. dubia	3369	1.9 *	390	1.46	75.3
C. dubia	3073	1.9 *	390	1.46	75.3
C. dubia	3091	1.9 *	390	1.46	75.3
C. dubia	3716	1.9 *	484	1.46	94.0
C. dubia	3506	1.9 *	484	1.46	94.0
C. dubia	3338	1.9 *	484	1.46	94.0
C. dubia	3051	1.9 *	578	1.46	112.8
C. dubia	2761	1.9 *	578	1.46	112.8
C. dubia	4220	1.9 *	578	1.46	112.8
C. dubia	2538	34	107	5.4	32.74
C. dubia	2607	34	107	5.4	32.74
C. dubia	2436	34	107	5.4	32.74
C. tentans	14123	1.9 *	94	1.46	17.6
C. tentans	14146	1.9 *	94	1.46	17.6
S. simile	1847	4.3	99	1.46	17.7
S. simile	2052	4.3	97	1.46	17.7
S. simile	2654	4.8	96	1.46	17.7
S. simile	2389	6.1	205	1.46	37.7
S. simile	2100	5.9	204	1.46	37.7
S. simile	3246	4.4	287	2.33	70.6
S. simile	2653	4.3	283	2.33	70.6
S. simile	2732	4.4	290	1.46	56.6
S. simile	2549	4.4	293	1.46	56.6
S. simile	3055	33.9	103	1.46	17.7
S. simile	2530	35.1	98	1.46	17.7
S. simile	2209	33.8	106	1.46	17.7
S. simile	2327	33.0	99	5.4	32.7
S. simile	2029	32.7	109	5.4	32.7

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- ^a The concentration of chloride is based on measured values of chloride with exceptions indicated by *. Values indicated by * are nominal concentrations based on formula used to make reconstituted water.
- ^b The reported hardness is the average of all values of hardness that were measured during the test and is stated in terms of calcium carbonate. Hardness values in parentheses are values used in calculation of equations described below. Values in parentheses are from beginning of test only.
- ^c Ratio of weights, based on the formula used to make the reconstituted water that was used as the dilution water.
- [†] Indicates test was used to generate the following equation using multiple regression with covariance (slopes from this equation were used in the Illinois sulfate criterion derivation):

$$C = [1646.5876 + 5.508 \text{ (hardness)} - 1.457 \text{ (chloride)}], R^2 = 0.8405, n = 42$$

Intercept for treatments (C. dubia = 182.07)

where, C = sulfate LC50 (mg/L)

- [@] Indicates test was used to generate the following equation using multiple regression (slopes from this equation were used in the Illinois sulfate criterion derivation):

$$C = [-57.4778 + 5.798 \text{ (hardness)} + 54.163 \text{ (chloride)}], R^2 = 0.8928, n = 28$$

where C = sulfate LC50 (mg/L)